Tree based Power Efficient Routing Techniques in Wireless Sensor Network: A Survey

Dhruti N. Vashi
P.G. Student, CO Department, Sarvajanik College of Engineering and Technology, Surat, India.

Urmi Desai
Prof., CO Department, Sarvajanik College of Engineering and Technology, Surat, India.

ABSTRACT
An incredible technology called wireless sensor network (WSNs) have attained too much enthusiasm in today's world. Sensor network is the bridge between real physical world and virtual world. WSNs use nodes which have capabilities to sense, store, distribute and collect the information. Low energy constraint system is the first requirement of any application. This paper aims to provide survey of tree based routing techniques keeping in view of energy efficiency.

Keywords
Wireless sensor network; minimum spanning tree; base station; energy efficient; routing algorithm.

1. INTRODUCTION
Popularity of the sensor network is mounting day by day in many fields. Main motive of the sensor network is sense the data and pass it to the base station (BS). For collect and transfer the information there is need of energy. Sensors have very limited energy source, so efficient utilization of energy is mandatory. So for this purpose many new techniques were developed and still continue. With fastest growing demand there is necessity of new inventions in technique which serve better lifetime to the sensors.

Initial technique was **direct transmission,** in which each node forwards its data straight to the base station. But it is not energy efficient. For moderate the numbers of nodes communicating straightly with the base station some techniques were proposed. **Cluster based routing** is one of them. In which nodes in entire network are separated by the clusters (see Figure 1). Each cluster elects one cluster head (CH) depending on different criteria. CH is responsible for transmit the data packet to the base station or sink. It is one kind of scalable and robust technique.

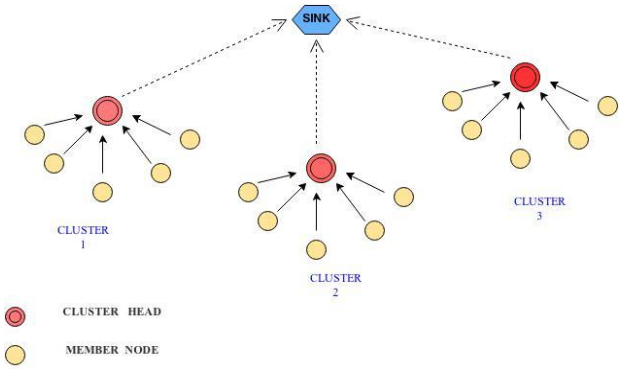

Figure 1: Cluster based routing

Chain based routing approach is one step ahead of cluster based approach than cluster based approach. As the name suggest there is a chain connecting all nodes where each node receive the data packets and transmit it to the nearest neighbor in the chain (see Figure 2).

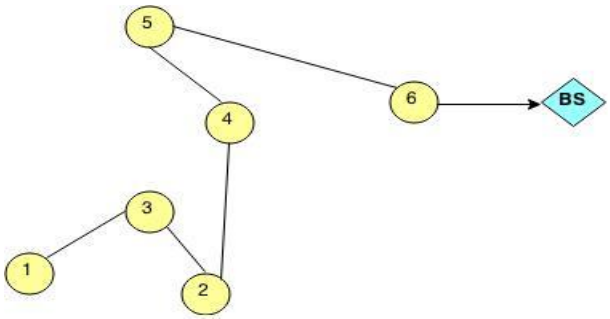

Figure 2: Chain based routing

Tree based routing approach is also used for power saving purpose. In which parent child relationship is maintained between nodes (see Figure 3). Child route the data packet to its parent, this parent route to its parent and so on. This way routing process is move on. This technique maximizes the lifetime and reduced the total energy consumed in a round.

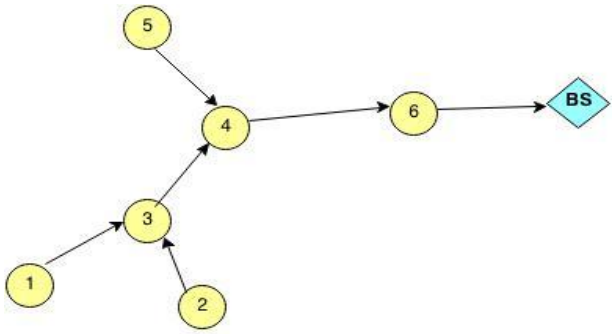

Figure 3: Tree based routing

2. EXPLORATION OF SEVERAL TREE BASED APPROACHES
Routing is the first and foremost requirement of sensor network for transferring the data to the BS. Arrangement of the node i.e. routing path has to be done with the aim of efficient power utilization. Here are some of techniques which are proposed for this motive.

2.1 Power–Efficient Data Gathering and Aggregation Protocol (PEDAP) [1]

In this algorithm prim's algorithm is used to build a minimum spanning tree for the routing purpose. BS is act as the root. In every iteration minimum weighted edge is selected which is not in the tree and added to tree. After some round base station will check all nodes were alive or not. Also it will check the energy level of each node in the tree.

2.2 Dynamic Minimal Spanning Tree Routing protocol (DMSTRP)[2]

This approach works for large area network. In DMSTR nodes are divided into the clusters. All nodes of the cluster are connected by a minimum spanning tree, this MST also include cluster head. One another MST is used for connecting the CHs. There are four states in which lifetime of the process are divided. And they are -1 as routed state, 0 as initial state, 1 as candidate state, and 2 as prepare state. The flow of this states are as:

Figure 4: States of lifetime

2.3 Balanced aggregation tree routing (BATR)[3]

In this algorithm for finding the optimal path balanced tree has been made. In this balanced tree all nodes have almost same number of child. BS knows the position of all nodes by using GPS. Path construction process is starts form BS. After every iteration minimum weighted edge is selected as per the decided child. The operational parameter μ which stands for number of child nodes can be calculated by:

$$\mu(R) = \frac{N*\Pi*R^2}{A} \quad [3]$$

Where, N stands for number of sensor nodes and A, R stands for radio transmission range. This process repeats until all nodes are included to the tree. After definite number of round BS further computes the routing information.

2.4 Cluster based Minimal Spanning Tree with Degree- Constrained (CMST-DC)[4]

This algorithm is divided into two phases. In the first phase cluster formation is done. CH is selected just as in LEACH algorithm. Then all nodes within the cluster make a tree using greedy algorithm. Then by connecting all cluster head higher level tree is made. Only one cluster head sends information to the base station. Minimum spanning tree is used to connect the nodes. The cluster head node is act as a starting node too. In the cluster find-nearest–neighbor (FNN) message is broadcast by cluster head for finding nearest as well as live nodes among all nodes. This way connection is done in the tree. After cluster formation phase next phase which is data transmission phase take place. In these sensors starts data collection operation. Each cluster head gathered data of its own cluster nodes.

2.5 Least-cost minimum spanning tree (LC-MST)[5]

In this approach for making the weighted graph G (V, E) distance matrix D= $[dij]_{nxn}$ is used. For all i,j, least cost element is fined in every column j and other element is set as 0. And by using this preferred link matrix (PLM) is constructed. By using PLM node set matrix (NSM) is built. NSM holds the pairs of node which are privileged in PLM. Then by combining the node pair candidate spanning tree is constructed. If there are duplicate set of nodes or any set of node pairs which make a cycle or any pairs have largest cost then it has been removed.

2.6 Tree based Routing protocol (TRP)[6]

In this technique it is assumed that sensor nodes are circulate in a circle field. For recognize the distance sensor node used Receive Signal Strength Indication (RSSI). First network is deployed and then sink broadcast a sink_ADV message to the network. Then each node estimate relative distance between itself and sink using RSSI, which is called d_sink. For creating a tree all nodes broadcasts HELLO (ID, d_sink, En). When nodes receives this message they computes relative distance d form neighbor. After that each node creates table which is neighbor information table. From this table each node decides about their neighbor and also about their parent. If sink node is in the range of communication then it kept as the next hope, and if not then the node which is closer to sink and has minimum cost is kept as neighbor node. This way tree is made. And sink is kept as root.

2.7 An Energy Efficient Scheduling Strategy for Data (EESS) [7]

In this paper problem of TDMA is solved in which because of more number packets sensor node have to wait until all other sensors complete their activity. In this approach entire network is divided into different groups which contain parent and child nodes. Parent node delivers the data to the sink which is collected from the child nodes. For preventing interference between nodes sensors were deployed as the spacing between them is kept as it is greater than or equal to the interference range. For each group load is calculated. Groups were scheduled as the decreasing order of the load. For scheduling strategy if two sensors of different groups are in the interference range of each other than they are not scheduled concurrently for transmission purpose.

2.8 Multiple Wireless Sensor Network Routing Protocol scheme [8]

In this proposed scheme network is divided into the cluster. Each member of the cluster was arranged into the single hope network topology. And cluster is again arranged in a tree structure, in which cluster head is connected. Each node has store the identity of the cluster head. Root node has the maximum number of child node. And as the level is increasing the number of child node is decreasing by $n/2^i$. Where n represent the number of child node of the parent node, i represent the level of the tree. Sink node randomly select one node in the cluster for the sensing purpose, which sense the data, store it and transfer it to the neighbor node. Neighbor node aggregates that data. This way all nodes in the cluster sense data and aggregate it until most of the cluster member has the identical value. Then randomly one of the nodes is selected for transfer the stored data to the cluster head. Cluster head is responsible for transfer this data to the sink node.

3. COMPARISION OF DIFFERENT TECHNIQUES

In PEADAP [1] Life time of the network is increases. And another advantage is expenditure of setting-up the system with fresh routing information is equivalent as only the sum of expenses of running the receiver circuitry of each node, But during the time of routing node may get dead and data can get lost.

DMSTR [2] consumes less delay, and also it is more energy efficient in large network area. But Lifetime of network is not changed greatly with increasing network area.

BATR [3] increases lifetime of the network also it balanced the power consumption for each node. But if any one node dies then it affects the multiple nodes.

CMST-DC [4] gives batter performance in network delay but in the process of finding the neighbor network traffic is greatly increases.

TRP [6] Fit for the environment when more node have data to send in each round but energy consumed in computes approximate distance and in generate neighbor table.

In [7] nodes do not have to wait for sending data if the number of packets is more but heavy loaded group have to wait until least loaded group send their data.

In [8] Reliability is high and network will not affected by node failure. But Time and memory is consumed because of every node aggregate the data.

In table: 1 comparison of existing technique based on some parameter is shown.

Table 1: Comparison of several existing methods

Approaches / Parameter	Neighbor is find by	Network traffic	Delay	Energy consumption	Characteristics
PEDAP[1]	BS	LESS	LESS	LESS	Prim's Algorithm based
DMSTRP[2]	BS	LESS	LESS	MEDIUM	Cluster base
BATR[3]	NODE	MEDIUM	MORE	MEDIUM	Balanced tree based
CMST-DC[4]	NODE	MORE	LESS	MORE	LEACH based cluster formation
LC-MST[5]	NODE	LESS	LESS	LESS	Least cost MST based
TRP[6]	NODE	MORE	MORE	HIGH	Neighbor table based
EESS[7]	BS	LESS	MORE	LESS	Scheduling based

4. CONCLUSION

In sensor network the primary problem is limited power. This paper represents survey of some techniques proposed for power saving purpose. So in future it is important to develop a technique which has security as well as consumes less power. For that tread-off can be done between energy consumption and security. For future work a technique can be developed which provide greater lifetime as well as security of confidential data.

5. REFERENCES

[1] H. Tan, I. Korpeoglu, "Power Efficient Data Gathering and Aggregation in Wireless Sensor Networks", ACM SIGMOD Record, pages 66-71, 2003 ACM.

[2] G. Huang, X. Li, and J. He, "Dynamic Minimal Spanning Tree Routing Protocol for Large Wireless Sensor Networks", 2006 IEEE.

[3] H. Kim, K. Han, "A Power Efficient Routing Protocol Based on Balanced Tree in Wireless Sensor Networks", 1st International Conference on Distributed Frameworks for Multimedia Applications, 2005 IEEE.

[4] C. Liang, Y. Huang and J. Lin "An Energy Efficient Routing Scheme in Wireless Sensor Networks", 22nd International Conference on Advanced Information Networking and Applications, 2008 IEEE.

[5] M. Hassan, "An efficient method to solve least-cost minimum spanning tree (LC-MST) problem", Journal of King Saud University – Computer and Information Sciences, pages 101-105, 2011 Elsevier.

[6] B. Gong, T Jiang, "A Tree-Based Routing Protocol in Wireless Sensor Networks", 2011 IEEE.

[7] P. Shrivastava, B. Pokle, "An Energy Efficient Scheduling Strategy for Data Collection in Wireless Sensor Network", International Conference on Electronic Systems, Signal Processing and Computing Technologies, 2014 IEEE.

[8] A. Chatterjee, D. Mukherjee, "Reliable Multiple Wireless Sensor Network Routing Protocol scheme for Network Lifetime Maximization", 2nd International Conference on Business and Information Management (ICBIM), 2014 IEEE.